CLAIMS

1. Tooling which is adapted to be secured to the movable end of a computer-controlled robotic arm, by which in use articles can be picked up from one position, optionally rotated in transit and lowered into a second position, which tooling comprises

(a) two blades each having a leading edge and trailing edge, and both being movable between a first position in which their leading edges are separated by a large gap and a second position in which the leading edges overlap, or are in contact or are separated by a smaller gap, and

(b) drive means for effecting relative movement between the two blades for moving them between the first and second positions,

whereby in use with the blades in the first position the tooling can be lowered so that the undersides of the two blades just make contact with a surface on which an article is resting with the two leading edges of the blades on opposite sides of the article and the latter can be picked up by the blades by operating the drive means so as to move the blades into their second position below the article.

2. Tooling as claimed in claim 1 wherein the thickness of the blades is selected so that the leading edges of the two blades slide between the article and the surface on which the article is located.

3. Tooling as claimed in claim 1 or 2 wherein the leading edge of each blade is bevelled or rounded so as not to present a cutting edge to the article.

4. Tooling as claimed in any of claims 1 to 3 wherein the drive means acts to move the two blades at high speed between the two positions, so that there is little tendency for

friction between the surface of the blades and the underside of the article to cause the latter to move laterally with either of the blades.

5. Tooling as claimed in any of claims 1 to 4 wherein the blades are similar in size and shape and thickness and are made from similar material and have a similar surface finish at least on their upper faces which in use make sliding contact with the underside of the article as they move into their second position.

6. Tooling as claimed in claim 5 wherein the surface finish of the undersides of the blades is also similar.

7. Tooling as claimed in any of claims 1 to 6 wherein the speed of movement of each blade is similar to that of the other.

8. Tooling as claimed in any of claims 1 to 6 wherein the movement of one blade is generally opposite to that of the other.

9. Tooling as claimed in any of claims 1 to 8 wherein the size and shape of the blades is selected so that the area of each blade available to slide below the article is greater than 50% of the area of the article.

10. Tooling as claimed in any of claims 1 to 9 wherein each of the trailing edges of the blades includes an upstanding lip or ridge or wall which in use will engage opposite edge regions of the article when the blades occupy their second position.

11. Tooling as claimed in claim 10 wherein each lip, ridge or wall is integral with its blade.

12. Tooling as claimed in claim 11 wherein each lip, ridge or wall is formed by bending up or moulding or otherwise forming the trailing edge of the blade.

13. Tooling as claimed in claim 10 wherein each lip, ridge or wall comprises a separate member which is secured to the upper face of the blade adjacent to its trailing edge.

14. Tooling as claimed in claim 13 wherein each separate member is secured by adhesive, or welding, or rivets, or screws.

15. Tooling as claimed in claim 13 or 14 wherein each separate member is spaced from the blade to facilitate cleaning.

16. Tooling as claimed in any of claims 1 to 13 further comprising a movement restraining mechanism, comprising article engaging means which in use is adapted to remain stationary while the blades move relatively thereto whereby the engagement between the article engaging means and the article will resist lateral or rotational movement of the latter relative to the tooling as a result of movement of the blades relative thereto, thereby in use to prevent unwanted rotational skewing or twisting or lateral movement of any kind, of an article relative to the blades, as the latter slide therebelow

17. Tooling as claimed in claim 15 wherein the article engaging means engages an upper face of an article over which the tooling is lowered.

18. Tooling as claimed in claim 16 or 17 wherein the movement restraining mechanism comprises one or more spikes which point generally perpendicularly towards the plane containing the two blades so that as the tooling is lowered onto an article the spikes penetrate the article before the blades make contact with a surface on which the article rests.

19. Tooling as claimed in claim 18 wherein the or each pointed end of the spike or spikes is spaced from the plane containing the blades by a distance which is less than the thickness of each article to be picked up by the tooling.

20. Tooling as claimed in claim 18 or 19 wherein the engagement of the spike or spikes and the article prevents lateral or rotational movement of the latter as the blades subsequently slide below the article either to pick up or release it.

21. Tooling as claimed in any of claims 18 to 20 wherein the movement restraining device further comprises ejector means which acts to push an article off the spike or spikes, as the blades move towards their second (open) position, so as in use to prevent an article remaining impaled on the spike or spikes, after the blades are opened to release the article.

22. Tooling as claimed in claim 21 wherein the ejector means is operated by the blade drive means.

23. Tooling as claimed in claim 21 wherein the ejector means is operated by a linkage which is operated in response to movement of at least one of the blades.

24. Tooling as claimed in any of claims 21 to 23 wherein the ejector means comprises at least one pin which is withdrawn upwardly as the blades move into their first (closed) position but is moved downwardly into a protruding position as the blades move into their second (open) position, so as to push an article in a similar downward direction, off the spike or spikes.

25. Tooling as claimed in claim 16 or 17 wherein the movement restraining mechanism comprises at least one resiliently deformable member located above the plane containing the two blades, and spaced therefrom by a distance which is less than the thickness of each article to be picked up by the tooling, so that in use as the tooling is lowered onto an article, the underside of the deformable means engages the upper surface of the article and the member becomes deformed in order to accommodate the thickness of the article before the blades make contact with a surface on which the article rests, the resulting downward force on the article, and frictional resistance to movement between the deformable means and the article, serving to restrain the latter

from moving under the influence of subsequent blade movement therebelow, either to pick up or to release the article..

26. Tooling as claimed in claim 25 wherein the deformable means comprises a block of resiliently deformable material, a sprung plate or block, or a dished plate of spring steel or the like.

27. Tooling as claimed in claim 25 wherein the deformable means comprises one or more fingers of spring steel or the like, having lateral stiffness but being adapted to deflect resiliently in an upward direction, relative to the blades. .

28. Tooling as claimed in claim 25 wherein the deformable means comprises one or more fingers of spring steel and is bent so as to point downwardly to engage the upper surface of the article, but which can be more or less flattened by an upward force, so as to accommodate the thickness of the article.

29. Tooling as claimed in claim 28 wherein the fingers include two or more further bends to increase the area of the finger in contact with the article.

30. Tooling as claimed in claims 16 or 17 wherein the movement restraining mechanism comprises a vacuum chuck which is adapted to become vacuum clamped to the upper surface of the article as the tooling moves downwardly onto the article, the vacuum clamping serving to resist movement of the article as the blades subsequently slide therebelow either to pick up or release the article.

31. Tooling as claimed in claim 30 wherein the vacuum chuck is adapted to release the article therefrom as or after the blades are opened, to deposit the article at its second position.

32. Tooling as claimed in claim 31 wherein the article release is effected using a positive pressure air pulse.

33. Tooling as claimed in any of claims 1 to 32 wherein in use rotation of an article in transit between the first and second positions is achieved by rotating one part of the robotic arm relative to another part thereof, or rotating the tooling relative to the robotic arm.

34. Tooling as claimed in claim 33 wherein the rotation restraining means comprises a vacuum chuck or two or more spikes each of which positively engages in the article, and rotation of the article is achieved by rotating the vacuum chuck or a member from which the spikes depend, in a plane which is generally parallel to the plane containing the two blades, so that the article is rotated relative to the blades.

35. Tooling as claimed in any of claims 1 to 34 wherein a support member is positioned above each of the blades, and drive means is provided for moving the support members and the blades which in use operates to move both the support members and the blades until an article is gripped between the support members and thereafter to move only the blades below the article, the drive means maintaining the support members in the article gripping position as the blades are subsequently withdrawn from below the article to prevent frictional drag on the underside of the latter from separating or moving the article.

36. Tooling as claimed in claim 35 wherein the drive means only operates to disengage the support members from the article after the blades have moved from below the article.

37. Tooling as claimed in claim 35 or 36 wherein the drive means for the blades and support members is at least one pneumatic cylinder.

38. Tooling as claimed in claim 37 wherein the cylinder is double acting.

39. Tooling as claimed in claim 37 wherein the cylinder is single acting in combination with return springs.

40. Tooling as claimed in any of claims 35 to 39 wherein a drive for the support members includes a lost motion connection in combination with a low spring rate compression spring which is compressed to the extent of the overrun created by the lost motion connection, and provides the lateral gripping force on the article when the support members are moved into article engagement, and also ensures that the lost motion is accommodated as the drive retracts.

41. Tooling as claimed in any of claims 35 to 39 wherein a first double acting pneumatic cylinder is adapted to move the blades and support members as a single unit, and a second double acting pneumatic cylinder is adapted to move the blades relative to the support members.

42. Tooling as claimed in claim 35 or 36 wherein the drive means comprises electric motors and/or electromagnetic solenoids and/or hydraulic drives.

43. Tooling as claimed in any of claims 35 to 42 wherein each support member is in sliding contact with the upper surface of the blade with which it is associated, so that the relative movement during closure on product and/or during opening to release the product, acts in a self-cleaning manner, and the support member can be thought of as scraping the upper surface of the blade.

44. Tooling as claimed in any of claims 35 to 43 wherein, after movement of the article to the said second position, the drive means is operated to retract the blades so as to align with the inner faces of the support members and thereafter the drive means is operated to retract both blades and support members in synchronism, by a distance just sufficient to release the article, so that the position of the article relative to the support surface remains substantially undisturbed from that determined by the position to which the tool has been moved.

45. Tooling as claimed in claim 44 wherein the tool is raised vertically clear of the article while the support members continue to locate the article in position until the tool has

been raised clear thereof, after which the drive means is operated to fully retract the support members and the blades.

46. Tooling as claimed in claim 45 wherein the step of fully retracting the support members and blades is effected in transit as the tool returns to pick up another article.

47. Tooling as claimed in claim 16 wherein the restraining means comprises an array of spaced apart displaceable elongate rod-like fingers which are mounted so as to extend generally normal to the plane containing the two blades, so that in use as the tool is lowered over an article with the blades retracted the lower ends of some of the fingers will engage the upper surface of the article and as a consequence will be pushed upwardly as the tool continues to move downwardly over and around the article, but other of the fingers which do not register with the article will not be pushed upwardly but will remain extended and will surround the article and in use will provide lateral support therefor as the blades subsequently move relative to the underside of the article both inwardly and outwardly.

48. Tooling as claimed in claim 47 wherein the fingers have pointed lower ends.

49. Tooling as claimed in claims 47 wherein the fingers have blunt lower ends.

50. Tooling as claimed in any of claims 47 to 49 wherein the fingers are resiliently biased in a direction towards the blades.

51. Tooling as claimed in any of claims 47 to 49 wherein the fingers are a sliding fit in guides so that if the blades are generally horizontal the fingers will be generally vertical and will drop under their own weight due to gravity.

52. Tooling as claimed in claim 51 further comprising stop means to prevent the fingers from dropping to the level of the blades so that engagement of blades and fingers is prevented.

53. Tooling as claimed in any of claims 47 to 52 wherein in use, when an article held by the tool is to be placed, the blades are first retracted to allow the article to drop from the tool or to pass therebetween as the tool is raised, and those fingers which had been elevated by the article fall back into line with the other fingers as the article and tool separate.

54. Tooling as claimed in any of claims 47 to 53 further comprising an additional drive means to positively push all the fingers in a downward manner after an article has been released from the tool.

55. Tooling as claimed in claim 54 wherein the additional drive means comprises a flat plate or pad mounted above the fingers which is supported by the upper ends of the fingers and can lift freely as fingers are forced up by an article therebelow, and which bears down on the fingers due to its own weight so as to force all the fingers which have been pushed up by an article, to drop down into line with the fingers which were not pushed up by the article, as the tool and article separate.

56. Tooling as claimed in claim 55 wherein the plate or pad is positively driven in a downward sense.

57. Tooling as claimed in claim 56 wherein the positive drive is effected by a pneumatic cylinder or electric motor or solenoid drive.

58. Tooling as claimed in claim 47 wherein each of the fingers comprises the piston of a pneumatic cylinder, and air pressure in the cylinders forces all the fingers in a downward sense.

59. Tooling as claimed in claim 58 further comprising relief valve means by which air is allowed to be released so as to maintain a constant pressure as fingers are pushed upwardly into their cylinders as their lower ends engage an article.

60. Tooling as claimed in any of claims 1 to 59 wherein the mechanism by which the two blades and/or support members (if provided) are caused to move is selected so as to exert negligible torque about the torsion drive axis of the robotic arm and/or about the rotational axis between the arm and the tooling and/or about any axis about which one part of the arm can rotate relative to another part thereof.

61. Tooling as claimed in claim 60 wherein the tooling includes a bridge which is adapted to be attached centrally to the robotic arm, to which the two blades are pivotally mounted at opposite ends, and to which is also connected the drive means by which the blades are moved between their first and second positions.

62. Tooling as claimed in claim 61 wherein the support members and their drive means are also connected to the bridge.

63. Tooling as claimed in claim 61 or 62 wherein the bridge is of aluminium or plastics as are any struts or mountings for attaching the blades and/or the supports to the bridge or drive or drives(s), so as to keep the weight of the tooling to the minimum.

64. Tooling as claimed in any of claims 1 to 63 wherein each plate is made from plastics or stainless steel, and typically is of the order of 0.5mm thick.

65. Tooling as claimed in any of claims 35 to 64 wherein each support member is made from plastics or stainless steel.

66. Tooling as claimed in claim 64 wherein an elongate Nylon® block is secured along but spaced from the trailing edge of each blade.

67. Tooling as claimed in any of claims 1 to 66 wherein the drive means acts equally and oppositely on the two blades.

68. Tooling as claimed in any of claims 35 to 67 wherein the drive means acts equally and oppositely on the two support members.

69. Tooling as claimed in any of claims 1 to 66 wherein the drive means acts on one of the blades with a connection between the two blades to transmit drive to the other blade so as to cause each to move in an appropriate manner.

70. Tooling as claimed in any of claims 35 to 67 wherein the drive means acts on one of the support members and a connection is provided between the two support members to transmit drive to the other support member so as to cause each support member to move in an appropriate manner.

71. Tooling as claimed in any of claims 67 to 70 wherein the drive means is double acting in the sense that it exerts a positive driving force on the or each blade and the or each support member if provided, in both directions of movement.

72. Tooling as claimed in any of claims 67 to 70 wherein the drive means acts only to move the blades and support members (if provided) in one sense, and spring means acts to move them back in the opposite sense once the drive means is de-energised or disengaged.

73. Tooling as claimed in any of claims 1 to 72 wherein the robotic arm includes a rotational drive, for rotating tooling attached thereto relative to the arm, whereby in use this is employed for orientating the tooling and therefore an article therein, during transit.

74. Tooling as claimed in any of claims 1 to 72 wherein the robotic arm includes a rotational drive which is employed to mechanically actuate drive means on the tooling for effecting relative movement of the blades and of the support members (if provided).

75. Tooling as claimed in claim 74 wherein the tooling includes a bridge and the blades are pivotable relative to the bridge, and drive means may be attached in part to the bridge to move the blades relative to the bridge and thereby relative to one another.

76. Tooling as claimed in claim 75 wherein drive means also acts in a similar manner on support members.

77. Tooling as claimed in any of claims 1 to 76 wherein in use just prior to their inward sliding movement below an article, the blades are pressed into contact with the flat support surface on which the article is carried, and a resilient lost motion connection is provided between the blades and the robotic arm, which permits the blades to make contact with the article support surface shortly before the downward movement of the end of the robotic arm carrying the tooling is stopped, and for the final movement of the robotic arm to compress the resilient lost motion connection after the blades make contact with the said surface, the energy stored in the compression of the resilient lost motion connection serving to exert a downward force on the blades which is resisted by the said surface and thereby to keep the blades in sliding contact with the surface as they move towards and slide under the article to enable the blades to close to their second position.

78. Tooling as claimed in claim 77 wherein the lost motion connection is between the robotic arm and the tooling or where the tooling includes a rigid bridge, is between the blades and the bridge.

79. Tooling as claimed in claim 77 or 78 wherein the blade drive means is attached in part to the bridge, and a lost motion connection is provided between the drive means and the bridge or between the drive means and the blade (or blades), to accommodate any lost motion between the bridge and the blades.

80. Tooling as claimed in claim 77 or 78 wherein the drive means is torsionally stiff in a plane parallel to that in which the blades move but is capable of flexing or distorting or

rising and falling as by pivoting in a plane which is perpendicular to the plane in which the blades move, so as to accommodate the lost motion between the blades and the bridge.

81. Tooling as claimed in any of claims 1 to 80 wherein the blades and where provided the support members rotate relative to one another and/or to a bridge forming part of the tooling, or slide linearly relative to each other or to the bridge.

82. Tooling as claimed in any of claims 1 to 81 in which the blades (and if provided the support members) are carried below a bridge, and the gap between the bridge and the blades is adjustable to allow different heights of article to be accommodated within the tooling.

83. Tooling as claimed in any of claims 1 to 82 wherein the gap between the blades and any supporting bridge is selected or adjusted so that in use a stack of two or more articles arranged one above the other can be picked up by the tooling.

84. Tooling as claimed in claim 83 wherein the height of any support members provided in combination with the blades is also selected according to the height of the articles in the stack.

85. Tooling as claimed in any of claims 1 to 84 wherein the article comprises two or more foodstuff portions, such as chops or steaks or fish fillets, arranged into a shingled array on the conveyor and the tooling is in use to pick and place the shingled array, without disturbing the relationship of the shingled portions.

86. Tooling as claimed in claim 85 wherein the tooling is orientated relative to a shingled array so that the two blades (and if provided the support members) advance towards the array along a line which is generally orthogonal to the direction in which the portions are shingled.

87. Tooling as claimed in any of claims 1 to 86 in combination with a viewing system which provides image signals to a robotic-arm-controlling computer, and the latter is programmed to determine the orientation of each article to be picked up and in particular the shingled direction of a shingled array, and to generate control signals for rotating the tooling accordingly to ensure that before the tooling engages an article, or stack of articles and in particular a shingled array, its orientation relative to the article or array is such that the blades (and if provided the support members) will move appropriately relative to the article or articles or array.

88. A product handling system comprising a first conveyor, a second conveyor spaced from the first, a robotic arm and computer control therefor, having tooling as claimed in any of claims 1 to 87 attached to its remote and movable end, both arm and tooling being controllable by signals from the computer control to position the tooling around an article on one conveyor and if provided move the support members into opposed contact with the article and to slide the blades thereof below the article, and thereafter lift the article from the one conveyor by appropriately controlling the robotic arm, and moving the arm and therefore the article-containing tooling so as to position it over the other conveyor and thereafter to open the blades and the support members (if provided) and deposit the article on the other conveyor.

89. A product handling system as claimed in claim 88 wherein the computer control is programmed to move the arm in a downward sense after the tooling has been positioned over the said other conveyor but before the blades (and support members if provided) are opened, thereby to control the distance (if any) through which the article has to drop onto the other conveyor on being released as the blades and support members (if provided) move apart..

90. A product handling system as claimed in claim 88 or 89 which includes camera means and sensor means which produce signals which are supplied to the computer and the latter is programmed to determine therefrom the position and/or orientation and/or nature of each article on the said one conveyor, and to generate control signals to cause

drives to operate to lift and/or rotate and/or lower the tooling and/or adjust the robotic arm so that the tooling is positioned at just the right time relative to an article travelling on the one conveyor to enable the tooling to pick it up therefrom, and if required to rotate it in transit, and thereafter position it on the other conveyor at precisely the right point in time and in the correct orientation.

91. A product handling system as claimed in claim 90 wherein said other conveyor has trays or other containers thereon, and the viewing system and sensors are set up so as to identify the precise position of each tray or container relative to the robotic arm, and the computer is programmed to control the movement of the said other conveyor as well as the said one conveyor, to ensure that a specific tray or container is at a specific position at a specific time to allow a specific article picked from the one conveyor to be placed in the said tray or container by the tooling carried by the robotic arm.